Risk Factors for Recurrence of Shoulder Instability After Arthroscopic Bankart Repair

Pascal Boileau, Matias Villalba, Jean-Yves Héry, Frédéric Balg, Philip Ahrens and Lionel Neyton
J. Bone Joint Surg. Am. 88:1755-1763, 2006. doi:10.2106/JBJS.E.00817

Risk Factors for Recurrence of Shoulder Instability After Arthroscopic Bankart Repair

By Pascal Boileau, MD, Matias Villalba, MD, Jean-Yves Héry, MD, Frédéric Balg, MD, FRCSC, Philip Ahrens, MD, FRCS, and Lionel Neyton, MD

Investigation performed at the Department of Orthopaedic Surgery and Sports Traumatology, Hôpital de L'Archet, University of Nice, Nice, France

Background: The higher failure rates reported with arthroscopic stabilization of traumatic, recurrent anterior shoulder instability compared with open stabilization remain a concern. The purpose of this study was to evaluate the outcomes of arthroscopic Bankart repairs with the use of suture anchors and to identify risk factors related to postoperative recurrence of shoulder instability.

Methods: Ninety-one consecutive patients underwent arthroscopic stabilization for recurrent anterior traumatic shoulder instability. The mean age (and standard deviation) at the time of surgery was 26.4 ± 5.4 years. Seventy-one patients were male. Seventy-nine patients were involved in sports (forty, in high-risk sports). Capsulolabral reattachment and capsule retensioning was performed with use of absorbable suture anchors (mean, 4.3 anchors; range, two to seven anchors). All patients were prospectively followed, and, at the time of the last review, the patients were examined and assessed functionally by independent observers.

Results: At a mean follow-up of thirty-six months, fourteen patients (15.3%) experienced recurrent instability: six sustained a frank dislocation and eight reported a subluxation. The mean delay to recurrence was 17.6 months. The risk of postoperative recurrence was significantly related to the presence of a bone defect, either on the glenoid side (a glenoid compression-fracture; $p = 0.01$) or on the humeral side (a large Hill-Sachs lesion; $p = 0.05$). By contrast, a glenoid separation-fracture was not associated with postoperative recurrent dislocation or subluxation. Recurrence of instability was significantly higher in patients with inferior shoulder hyperlaxity ($p = 0.03$) and/or anterior shoulder hyperlaxity ($p = 0.01$). On multivariate analysis, the presence of glenoid bone loss and inferior hyperlaxity led to a 75% recurrence rate ($p < 0.001$). Lastly, the number of suture-anchors was critical: patients who had three anchors or fewer were at higher risk for recurrent instability ($p = 0.03$).

Conclusions: In the treatment of traumatic recurrent anterior shoulder instability, patients with bone loss or with shoulder hyperlaxity are at risk for recurrent instability after arthroscopic Bankart repair. At least four anchor points should be used to obtain secure shoulder stabilization.

Level of Evidence: Therapeutic Level IV. See Instructions to Authors for a complete description of levels of evidence.

Biomechanical and clinical studies have shown that traumatic dislocation or subluxation of the shoulder leads to labral detachment from the glenoid, a so-called Bankart lesion, and to elongation of the capsular ligamentous restraints[1-5]. The open Bankart technique has been established as the so-called gold standard for the treatment of anterior instability[6,7]. Arthroscopic stabilization for this problem has evolved from the use of metallic staples to transglenoid sutures, to absorbable rivets, and to suture anchors[8-14]. Early arthroscopic stabilization techniques had failure rates that were higher than those of open Bankart stabilization[15-17]. Our own experience with arthroscopic stabilization began fifteen years ago and was disappointing. The results of our study, reported in 1995, yielded a 49% recurrence rate with use of transglenoid sutures[18]. These disappointing results led to the abandonment of arthroscopic shoulder stabilization and to our return to open Bankart repair.

In 1999, we reevaluated arthroscopic Bankart stabilization as we believed that techniques and implants had evolved sufficiently to allow better fixation. We adopted the technique with use of suture anchors described by Wolf[19], as the failure rates described with the suture-anchor technique were acceptable[20-23]. Arthroscopic stabilization with suture anchors is, however, still developing, and, as indications and contraindications are not well defined, several questions still need to be answered.

The purpose of this study was to report our recent experience with arthroscopic shoulder stabilization using suture anchors and to identify, through a retrospective case series, specific factors related to the postoperative recurrence of shoulder instability. We hypothesized that an arthroscopic procedure that used modern techniques would treat instability more effectively than previous techniques reported for patients with traumatic, recurrent anterior instability.

Materials and Methods

Inclusion and Exclusion Criteria

In order to evaluate the value of this arthroscopic Bankart procedure, we decided to perform this operation only in a series of consecutive patients with traumatic, recurrent anterior instability, regardless of the preoperatively identified lesions. The criteria for inclusion were (1) the presence of traumatic, recurrent anteroinferior shoulder instability, (2) labral repair and capsule retensioning with use of a single arthroscopic technique with suture anchors, (3) surgery performed by the senior surgeon (P.B.) or under his direction, and (4) a clinical examination and interview with the patient performed at least two years after surgery by independent observers.

Exclusion criteria were (1) arthroscopic stabilization for acute (first) anterior dislocation or subluxation; (2) arthroscopic stabilization after a previous failed instability repair; (3) patient preference for open stabilization; (4) other types of instability such as voluntary instability, posterior instability, and multidirectional instability (defined as instability in three directions)[24].

Between July 1999 and August 2001, 100 consecutive patients who had arthroscopic Bankart repairs for traumatic, recurrent anterior shoulder instability, with use of suture anchors, met the inclusion criteria.

Study Population

Nine patients were lost before two years of follow-up, leaving a cohort of ninety-one patients available at the time of the final review. Seventy-one patients (78%) were male. The mean age of the patients was 21.5 ± 3.5 years (range, twelve to forty-nine years) at the time of injury and 26.4 ± 5.4 (range, seventeen to sixty-two years) at the time of surgery. The dominant side was involved in fifty-three patients (58%). Bilateral anterior instability was present in fifteen patients (16%). The diagnosis of anterior instability was made when there was a history of subluxation with spontaneous reduction or a history of dislocation requiring manual reduction, and all patients had a positive anterior apprehension and relocation test[25,26]. Twenty-two patients had recurrent dislocations, thirty-nine had recurrent subluxations, and thirty had both subluxations and dislocations. The average number of instability episodes varied, with seven episodes (range, two to forty) for the patients with dislocations, twenty-three episodes (range, two to 150) for the patients with subluxations, and twenty episodes (range, two to 103) for the patients with dislocations and subluxations. Seventy-nine patients (87%) were involved in sports, with forty (44%) who participated in high-risk sports with contact and/or throwing. Twenty-four patients (26%) played at a competitive, recreational level.

Preoperative Evaluation of Shoulder Laxity

Shoulder laxity was evaluated by clinical examination. Anterior shoulder hyperlaxity was defined as external rotation of >90° with the arms at the side (reaching the frontal plane). This sign is usually bilateral and is an indicator of a congenitally weak anterior capsule[27]. These patients were also found to have general ligamentous hyperlaxity. Nine patients demonstrated anterior hyperlaxity.

Inferior shoulder laxity was defined as a difference of >20° between sides on hyperabduction (the Gagey test)[28,29]. This sign is usually unilateral and is an indicator of a stretched inferior capsule because of plastic deformation of the inferior glenohumeral ligament secondary to instability[29]. Twenty-six patients demonstrated such inferior laxity. Sixteen patients were considered to have a stretched inferior glenohumeral ligament.

Evaluation of Osseous Lesions and Bone Loss

All patients underwent a preoperative radiographic evaluation, including anteroposterior radiographs made with the arm in three different rotations (neutral, external, and internal), a scapular lateral radiograph, and an axillary radiograph. Assuming that bone loss was a risk factor for the recurrence of instability, we asked our patients to have a preoperative computed tomographic scan, unless they already had a magnetic resonance imaging scan. Preoperative computerized tomography scans were available for sixty-six patients. All patients had an arthroscopic examination, with the arthroscope placed first in the posterior portal and then in the anterior portal. Evaluation was initially performed with use of 20 mL of air insufflation to gauge the humeral transla-

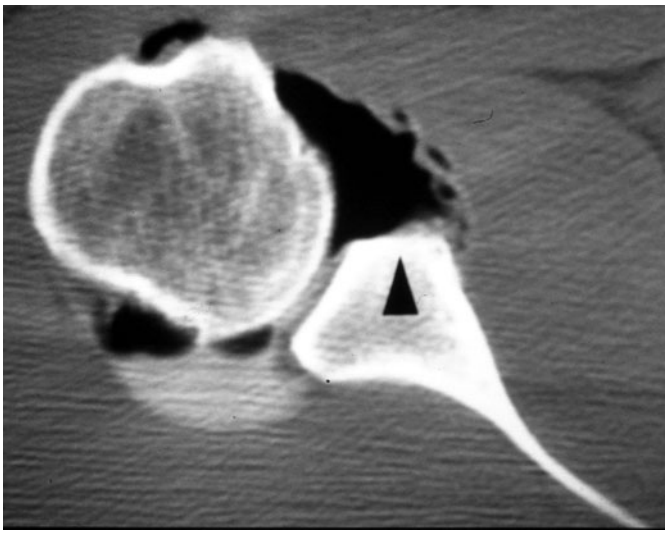

Fig. 1

A glenoid bone defect (a compression fracture [arrowhead] without any bone fragment, involving >25% of the glenoid surface) is demonstrated on this computed tomography scan.

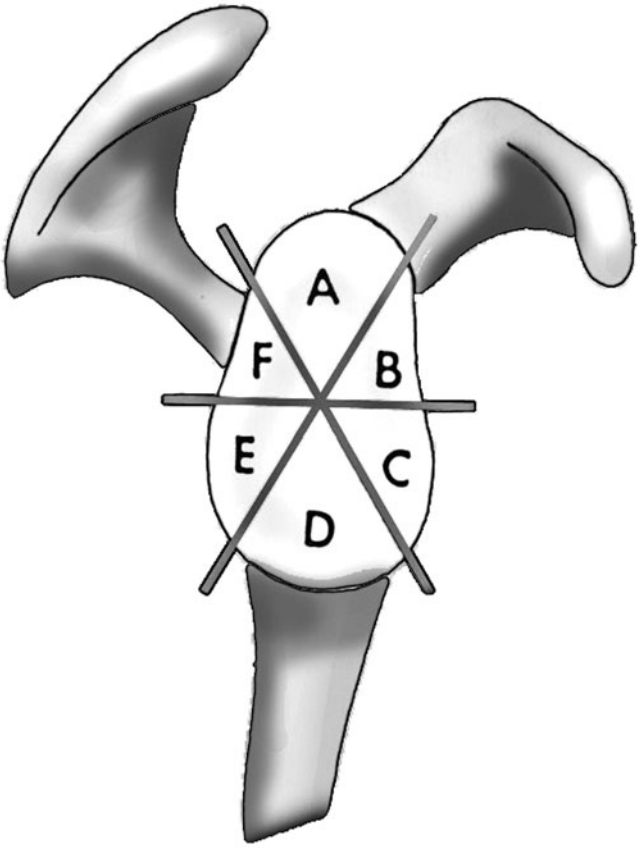

Fig. 2

Labral detachment from the glenoid rim was divided into six zones (A, B, C, D, E, and F).

tion, and then it was done with normal saline solution.

The glenoid surface was considered normal in forty-six patients, while osseous lesions were seen in forty-five patients (49%): a glenoid fracture with a detached bone fragment (shear or avulsion-fracture) was found in thirty-four patients (37%) and a glenoid bone defect without any detached bone fragment (compression-fracture), in twelve patients (13%) (Fig. 1). We did not attempt to quantify the bone fragment or defect with computed tomography scans because a standardized radiographic protocol was not utilized. Amputation of the anterior glenoid surface was estimated preoperatively by dividing the glenoid rim into six sections of approximately 30° (A, B, C, D, E, and F) (Fig. 2). The term "glenoid bone defect" was applied if ≥25% (more than one section) of the anterior glenoid rim were missing.

On the humeral side, a Hill-Sachs lesion was present in seventy-six patients (84%) (Figs. 3-A and 3-B). This lesion was considered to be "small" in sixty-four patients and "large" in twelve patients (13%). No attempt was made to measure accurately the size of the bone defect in the humeral head with computed tomography scans because a standardized protocol was not used. The term "humeral bone defect" was arbitrarily applied if a clinically "important" part of the humeral head surface was missing on assessment during the arthroscopic procedure.

Evaluation of Labral and Ligamentous Lesions

Arthroscopic examination was used to evaluate the extent of the labral detachment around the glenoid, the degree of capsular laxity, and the quality of the tissue by direct visualization

Fig. 3-A

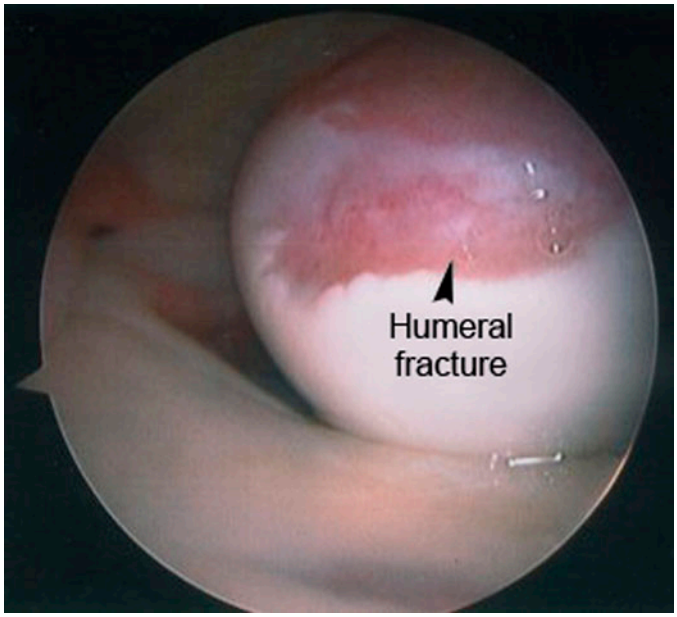

Fig. 3-B

A humeral bone defect (a large Hill-Sachs lesion involving >25% of the articular head surface) can be appreciated on the anteroposterior radiograph made with the shoulder in internal rotation (Fig. 3-A) and during arthroscopy (the arthroscope is posterior) (Fig. 3-B).

and palpation with a probe[30]. The glenoid rim was divided into six regions (A, B, C, D, E, and F) by two imaginary oblique lines drawn from eleven o'clock to five o'clock and from one o'clock to seven o'clock, and an imaginary transverse line drawn at the equator of the glenoid (Fig. 2)[31].

Labral detachment from the glenoid rim (i.e., a Bankart lesion) was present in eighty-two patients (90%). The labrum was detached, together with the capsule, in seventy-five patients, and it was torn in a bucket-handle configuration in seven patients. According to the extent and location of the labral detachment, seven types of lesions were found: C (two patients), BC (eight), BCD (thirty-nine), ABC (eleven), ABCD (nineteen), and ABCDE (three). In the remaining nine patients (10%), no Bankart lesion was found, but the capsule was either stretched or torn.

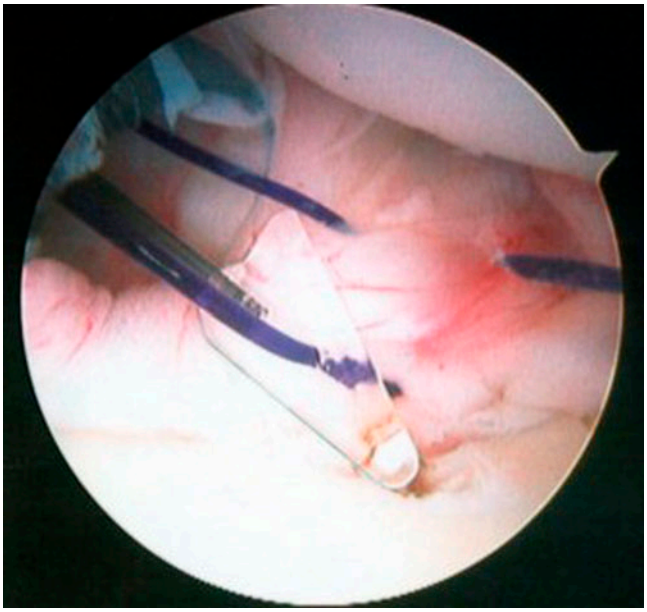

Fig. 4-A
Arthroscopic image showing insertion of an absorbable anchor.

Surgical Technique

All surgery was performed with use of a standardized technique by the senior surgeon (P.B.). The patient was placed in the beach-chair position, and the affected upper extremity was prepared and draped. A standard 30° arthroscope was utilized. The posterior portal was created 1.5 cm inferior and medial to the posterolateral corner of the acromion. The anterosuperior portal was created adjacent to the anterior edge of the acromion through the rotator interval in an "outside-in" fashion. A needle was used to locate the desired position to allow both an appropriate angle of approach to the glenoid (not too tangential to the articular surface) and to ensure easy access to the anteroinferior capsule and labrum. A complete evaluation of the capsular and osseous lesions was then performed. The surgeon evaluated the amount of capsular shift needed, depending on the quality of the tissue and the severity of the capsular stretch.

The labral detachment was completed, or created, with a Bankart rasp and electrocautery. The rasp was used to detach and then elevate the soft tissue from the glenoid rim with a lever arm maneuver. The goal was to mobilize the inferior glenohumeral ligament and labrum such that it could be shifted superiorly and laterally. Visualization of the fibers of the subscapularis muscle beneath the labrum and a sensation of elasticity of the inferior glenohumeral ligament when pulled with a grasper were evidence of a satisfactory soft-tissue release. The glenoid neck was then decorticated with use of a shaver and burr to create a cancellous bed to aid tissue-healing. Depending on the size of the articular surface, three or four holes were drilled in the glenoid rim at five, four, three, and two or one o'clock. The holes were drilled at the margin of the articular surface to allow recreation of the glenoid concavity (Figs. 4-A and 4-B).

A Wolf hooked needle (Linvatec, Largo, Florida) was used to pass a suture (PDS II #1; Ethicon, Johnson and Johnson, Somerville, New Jersey) in the most inferior part of the capsule, through both the labrum and the capsule. The suture was placed on an absorbable anchor (Panalok; Mitek,

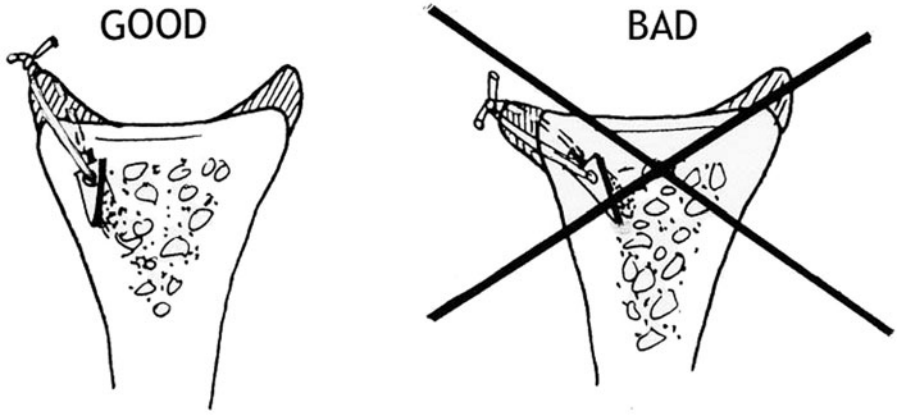

Fig. 4-B
Drawings demonstrating the optimal placement of anchors on the glenoid rim to recreate normal articular concavity.

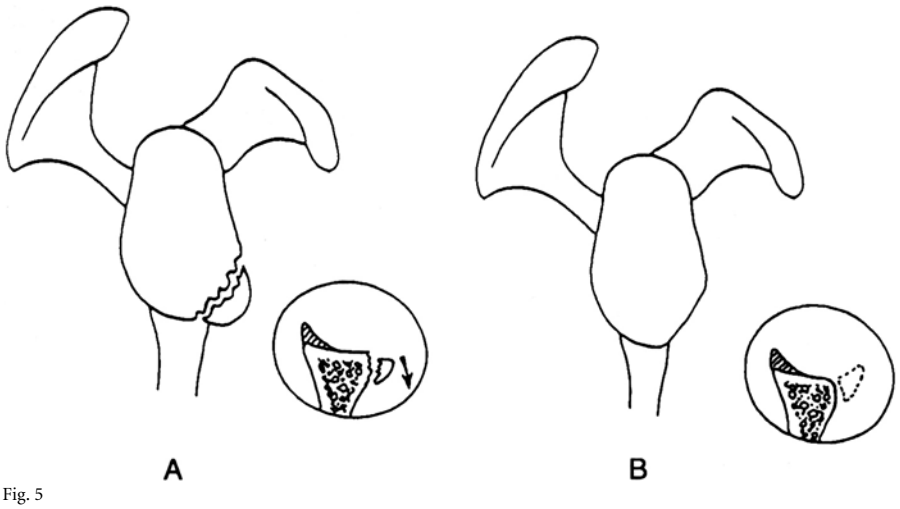

Fig. 5

Two types of glenoid rim fractures associated with anterior instability that should be differentiated include separation fractures with avulsion of a bone fragment *(A)* and compression fractures without any bone fragment *(B)*.

Johnson and Johnson) and inserted in the most inferior hole, at the five o'clock position. The same maneuver was then performed to pass other sutures, which were inserted with an anchor at the four, three, and two o'clock positions, respectively. The average number of anchors used was 4.3 (range, two to seven). Nine patients (10%) had no Bankart lesion; we performed a capsular plication in four of them, and we created a Bankart lesion that was later repaired, in addition to performing a capsular plication, in the remaining five patients.

Postoperative Care

The patients were managed with the arm in a sling in internal rotation for four weeks. Passive pendulum exercises were started on the day after surgery. Patients were advised to perform these exercises five times a day for five minutes at a time

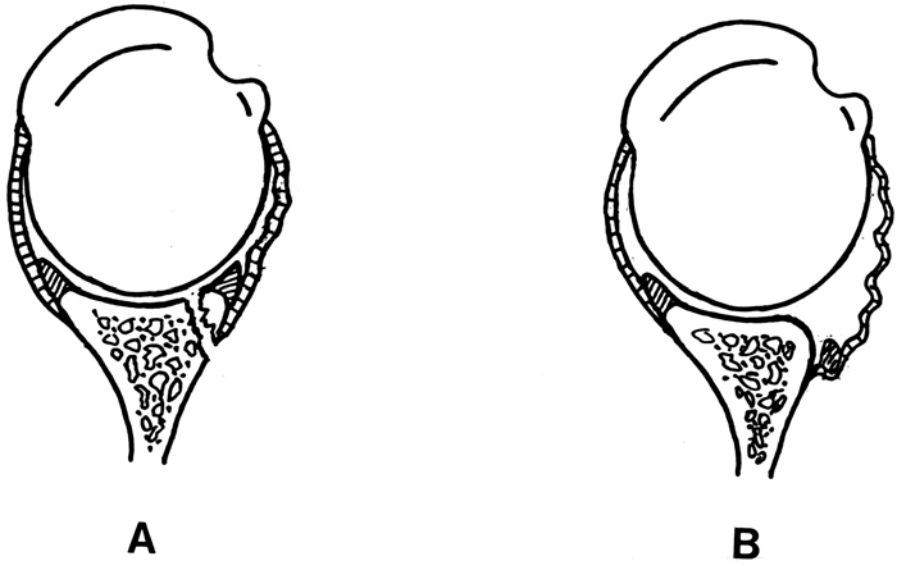

Fig. 6

When the capsule is strong and of good quality, an instability episode results in a fracture separation without substantial capsular stretching: the weak link in the chain is the bone and not the ligament *(A)*. In contrast, if the capsule is weak, it will elongate and the glenoid rim will be compressed and eroded by the recurrent subluxations or dislocations leading to a compression fracture *(B)*. In this situation, two weak links in the chain are the loose capsule and the glenoid bone loss; the risk for recurrent instability is higher.

TABLE I Functional Results According to the Walch-Duplay and Rowe Scoring Systems

Walch-Duplay Score*		Rowe Score	
Description	Mean Score *(points)*	Description	Mean Score *(points)*
Sport or activity	19.3	Function (maximum score, 50)	39.1
Stability	15.1	Stability (maximum score, 30)	21
Pain	20.9	Pain (maximum score, 10)	8.4
Mobility	22.5	Mobility (maximum score, 10)	8.8
Total	74.8	Total (maximum score, 100)	77.8

*Each category has a maximum score of 25 points, for a maximum total score of 100 points.

for the first four weeks. Rehabilitation with a physiotherapist began at thirty days. External rotation was limited to 45° until day 45. Strengthening was started between eight and twelve weeks, with return to sports delayed until four to six months postoperatively.

Functional Evaluation

All patients returned for a follow-up evaluation at three, six, and twelve months and then yearly thereafter. At the time of the last review, all patients were examined and interviewed by two independent observers (M.V. and J.Y.H.). The mean duration of follow-up was thirty-six months (range, twenty-four to fifty-six months). Physical examination included the shoulder range of motion and instability signs (apprehension test and relocation test). The Rowe and Walch-Duplay scores (see Appendix) were performed at each review[32].

Definition of Failure

The recurrence of instability was considered a failure. This means that any postoperative dislocation or any subjective complaint of occasional to frequent subluxation was considered a failure.

Statistical Analysis

The chi-square test, Yates-corrected chi-square test, Student t test, and Fisher variance analysis were used. The level of significance was set at $p < 0.05$. Analysis was performed with use of StatView 5.0 (SAS Institute, Cary, North Carolina).

Results

Stability

A true recurrence (dislocation or subluxation) was present in fourteen (15%) of the ninety-one patients who were available for review. Thirteen patients who had a recurrence of instability were male. Seven of those patients experienced a new, important traumatic event, while the other seven patients did not. Six patients sustained a true dislocation, and eight reported a subluxation. The mean delay to recurrence was 17.6 months (range, seven to thirty-two months). Nine patients had a recurrence more than one year after surgery; five of them had a recurrence between one and two years, and the other four had a recurrence at more than two years postoperatively. The number of recurrences was constant throughout the study period. Nine of the fourteen patients underwent open revision surgery with a Latarjet procedure, which resulted in a stable shoulder in all of them. The five remaining patients declined additional surgery.

Moreover, nine patients had a persistent apprehension sign in the throwing position (a positive apprehension test). The apprehension was severe enough to interfere with sports or in some activities of daily living. Seven of these nine patients, however, were satisfied or very satisfied with the results of surgery.

Functional Results

The mean Rowe score was 77.8 points (range, 15 to 100 points), and the mean Walch-Duplay score was 74.8 points (range, 15 to 100 points). Detailed scores are summarized in Table I. Sixty-two patients (68%) had good or excellent results according to both scores. A return to sports was evaluated in the seventy-seven patients who had no recurrence of instability. Fifty-eight patients (75%) went back to sports at the same level, thirteen (17%) went back to sports but at a lower level, and six (8%) stopped participating in any sports.

Subjective Results

Fifty-three patients (58%) were very satisfied, seventeen (19%) were satisfied, eleven (12%) were disappointed, and ten (11%) were dissatisfied.

Risk Factors Associated with Recurrence of Instability

We compared the fourteen patients who had a recurrence of instability with the seventy-seven patients considered to be successes in order to determine potential factors related to failure. We found several factors that were associated with recurrent instability. First, glenoid bone loss (erosion or a compression fracture involving >25% of the glenoid surface), without any bone fragment detached, was found to be significantly associated with failure ($p = 0.01$). Interestingly, with the numbers available, a glenoid fracture (with detachment of a bone fragment or an avulsion fracture) was not associated with a higher failure rate ($p = 0.59$). Other factors significantly related to failure included humeral bone loss categorized as a large Hill-Sachs lesion ($p = 0.05$) and a stretched inferior gle-

nohumeral ligament ($p = 0.03$) or anterior hyperlaxity ($p = 0.01$). Last, the number of sutures and anchors was significantly related to failed arthroscopic stabilization; specifically, patients who had three anchors or fewer had higher rates of recurrent instability ($p = 0.03$).

On multivariate analysis, we found that the presence of a stretched inferior glenohumeral ligament, anterior hyperlaxity, or a glenoid compression fracture involving >25% of the glenoid surface led to a 75% recurrence rate ($p < 0.001$).

With the numbers studied, other potential prognostic factors frequently described in the literature were not found to be significant in the present series. Specifically, the age of the patient at the time of the first episode, gender, dominant arm, type of sport (contact or no contact), type of instability (dislocation or subluxation), number of episodes, bilateral instability, presence of a superior labrum anteroposterior lesion, or absence of a Bankart lesion did not influence the recurrence rate[33-38].

Complications

No complications were related to the anchors or sutures. One patient had an acute infection that resolved with arthroscopic débridement and antibiotics; the shoulder was stable at the time of the last review. Three patients were considered to have a stiff shoulder, lacking >20° in passive elevation and external rotation. One patient had persistent pain, but no explanation was found.

Discussion

In the present study, we found that arthroscopic shoulder stabilization with use of suture anchors led to a postoperative recurrence of instability in 15% of the patients at a mean follow-up of thirty-six months. Although the recurrence rate may increase with time, these results are similar to those in the few previous reports on arthroscopic stabilization with use of suture anchors[20,21,23,38-40]. In comparable series, Kandziora et al.[39] and Kim et al.[40] reported failure rates of 16.5% and 10%, respectively. The failure rate in our study compares favorably with those of Koss et al.[21] and Lafosse[41] who reported rates of 30% and 18.5%, respectively. A lower recurrence rate of 8% was reported by both Gartsman et al.[20] and Tauro[23] who added shrinkage or inferior capsular tensioning to the capsulolabral repair. In our patients, we did not use thermal shrinkage.

We found, as others have, that the number of fixation points is important for the success of anterior arthroscopic stabilization[40]. In the present study, patients who had three or fewer anchors had a higher rate of recurrent instability. These results suggest that four anchor points, at a minimum, should be used to obtain secure shoulder stabilization, regardless of the initial extent of the Bankart lesion.

Patients with bone defects (either on the glenoid or the humeral side) are at risk of failure; they are, therefore, poor candidates for such a procedure. In our study, the risk of postoperative recurrence was significantly related to an osseous bone loss of the posterior aspect of the humeral head (a large Hill-Sachs lesion) or of the anterior glenoid rim (a compression fracture with a discrete bone fragment). By contrast, glenoid avulsion fractures (with separation of a bone fragment) did not compromise the chance of success (Fig. 5).

The fact that glenoid bone loss is associated with postoperative recurrence is not surprising. It has been shown that an anterior glenoid bone defect can affect glenohumeral stability in two ways. First, loss of part of the glenoid surface reduces the concavity of the glenoid, and, second, the arc length of the glenoid is decreased[42-46]. Recently, Burkhart et al.[47] and Lo et al.[48] suggested that it is possible to quantify glenoid bone loss in shoulder instability arthroscopically: the "inverted pear shape" of the glenoid is an indicator of substantial glenoid bone loss. According to those authors, the bare spot of the glenoid is the landmark that the arthroscopist should look for since it is equidistant to the anterior, posterior, and inferior glenoid rim in a normal shoulder. Those authors, in a cadaver study, measured the distance from the center of the bare spot to the rim and observed an average distance of 11 mm[47]. In a recent paper, Kim et al. also quantified glenoid bone loss and found that postoperative recurrence was related to an osseous defect of >30% of the entire glenoid circumference[49]. To help with patient selection, preoperative radiographs like the Garth or Bernageau radiographs and, more recently, preoperative computed tomography scans with sagittal reconstruction have been recommended to detect and quantify such glenoid bone loss[49-53].

The fact that humeral bone defects (i.e., large Hill-Sachs lesions) lead to postoperative recurrent instability after arthroscopic Bankart repair is not surprising either. The articular arc deficit of the humeral head allows engagement of the bone defect on the anterior glenoid rim, the so-called engaging Hill-Sachs lesion[44]. In the present study, we did not look for such potential engagement of the humeral defect on the anterior glenoid rim during arthroscopy; the Hill-Sachs lesion was just qualified as "large" on the basis of arthroscopic observation. Sophisticated radiographic methods to measure humeral bone defects in anterior shoulder instability have recently been proposed by Kralinger et al.[54] and Ito et al.[55]. Hopefully, in the near future, it will be possible to accurately quantify humeral bone defects with the help of preoperative computed tomography scans.

Another important finding of the present study is that patients with ligamentous hyperlaxity of the shoulder are at risk for a recurrence of instability after arthroscopic stabilization. Hyperlaxity is difficult to analyze because its definition is variable[27,56-59]. Excessive external rotation with the arm at the side, that is, rotation of >90°, has been reported to be an indicator of shoulder hyperlaxity and a risk factor for postoperative instability; this was confirmed in the present series[58,59]. This sign is almost always bilateral and is, for us, an indicator of anterior hyperlaxity, resulting from a congenitally lax anterior capsule.

In addition, we found that a stretched inferior glenohumeral ligament, defined as a preoperative asymmetrical hyperabduction test of >20° compared with the contralateral side, was associated with failure of the arthroscopic stabilization. We

found the hyperabduction test of Gagey to be valuable for the detection of inferior laxity[28,29]. It has been our experience that such inferior laxity is, most of the time, acquired and related to the amount of plastic deformation of the inferior axillary pouch after recurrent dislocations or subluxations.

Finally, we found that the association of a glenoid compression fracture and a stretched inferior glenohumeral ligament leads to a 75% recurrence rate; therefore, we believe that the combination of hyperlaxity (external rotation of >90° and/or hyperabduction) and glenoid bone loss is a formal contraindication to an arthroscopic Bankart repair (Fig. 6). It is incumbent on the surgeon to be aware of this pathologic association and to treat it appropriately.

In summary, this retrospective study suggests that bone loss (on the glenoid and/or on the humeral side) and/or ligamentous hyperlaxity represent contraindications to arthroscopic shoulder stabilization. Those conditions clearly compromise the chance of success of an arthroscopic Bankart repair. It should be noted that nine of the fourteen patients who had failure of arthroscopic treatment underwent revision with a Latarjet procedure, which resulted in a stable shoulder in all of them[60]. The results of the present study have encouraged us to continue with arthroscopic treatment for recurrent anterior instability with two caveats: patient selection and rigorous technique. We reserve arthroscopic treatment for patients with minimal to no humeral or glenoid bone loss. Moreover, we use a technique that allows an optimal capsular shift and tensioning[61].

Appendix

eA Tables showing the Rowe and Walch-Duplay scores are available with the electronic versions of this article, on our web site at jbjs.org (go to the article citation and click on "Supplementary Material") and on our quarterly CD-ROM (call our subscription department, at 781-449-9780, to order the CD-ROM). ■

Pascal Boileau, MD
Matias Villalba, MD
Jean-Yves Héry, MD
Frédéric Balg, MD, FRCSC
Philip Ahrens, MD, FRCS
Lionel Neyton, MD
Department of Orthopaedic Surgery and Sports Traumatology, Hôpital de l'Archet, University of Nice, 151, Route de St. Antoine de Ginestière, 06202 Nice, France. E-mail address for P. Boileau: boileau.p@chu-nice.fr

The authors did not receive grants or outside funding in support of their research for or preparation of this manuscript. They did not receive payments or other benefits or a commitment or agreement to provide such benefits from a commercial entity. No commercial entity paid or directed, or agreed to pay or direct, any benefits to any research fund, foundation, educational institution, or other charitable or nonprofit organization with which the authors are affiliated or associated.

doi:10.2106/JBJS.E.00817

References

1. Bigliani LU, Pollock RG, Soslowsky LJ, Flatow EL, Pawluk RJ, Mow VC. Tensile properties of the inferior glenohumeral ligament. J Orthop Res. 1992;10:187-97.

2. Speer KP, Deng X, Borrero S, Torzilli PA, Altcheck DA, Warren RF. Biomechanical evaluation of a simulated Bankart lesion. J Bone Joint Surg Am. 1994;76:1819-26.

3. Hayashida K, Yoneda M, Nakagawa S, Okamura K, Fukushima S. Arthroscopic Bankart suture repair for traumatic anterior shoulder instability: analysis of the causes of a recurrence. Arthroscopy. 1998;14:295-301.

4. Green MR, Christensen KP. Arthroscopic Bankart procedure: two- to five-year followup with clinical correlation to severity of glenoid labral lesion. Am J Sports Med. 1995;23:276-81.

5. Bankart ASB. The pathology and treatment of recurrent dislocation of the shoulder joint. British Med J. 1938;26:23-9.

6. Rowe C, Patel D, Southmayd WW. The Bankart procedure: a long-term end-result study. J Bone Joint Surg Am. 1978;60:1-16.

7. Gill TJ, Micheli LJ, Gebhard F, Binder C. Bankart repair for anterior instability of the shoulder. Long-term outcome. J Bone Joint Surg Am. 1997;79:850-7.

8. Lane J, Sachs R, Riehl B. Arthroscopic staple capsulorrhaphy: a long-term follow-up. Arthroscopy. 1993;9:190-4.

9. Detrisac DA, Johnson LL. Arthroscopic shoulder capsulorrhaphy using metal staples. Orth Clin North Am. 1993;24:71-88.

10. Steinbeck J, Jerosch J. Arthroscopic transglenoid stabilization versus open anchor suturing in traumatic anterior instability of the shoulder. Am J Sports Med. 1998;26:373-8.

11. Torchia ME, Caspari RB, Asselmeier MA, Beach WR, Gayari M. Arthroscopic transglenoid multiple suture repair: 2 to 8 year results in 150 shoulders. Arthroscopy. 1997;13:609-19.

12. Speer KP, Warren RF, Pagnani M, Warner JJ. An arthroscopic technique for anterior stabilisation of the shoulder with a bioabsorbable tack. J Bone Joint Surg Am. 1996;78:1801-7.

13. Dora C, Gerber C. Shoulder function after arthroscopic anterior stabilization of the glenohumeral joint using an absorbable tack. J Shoulder and Elbow Surg. 2000;9:294-8.

14. Abrams JS. Shoulder stabilization and evolving trends in arthroscopic repair. Sports Medicine and Arthroscopic Review. 1999;7:104-16.

15. Stein DA, Jazrawi L, Bartolozzi AR. Arthroscopic stabilization of anterior shoulder instability: a review of the literature. Arthroscopy. 2002;18:912-24.

16. Grana WA, Buckley PD, Yates CK. Arthroscopic Bankart suture repair. Am J Sports Med. 1993;21:348-53.

17. Cole BJ, Warner JJ. Arthroscopic versus open Bankart repair for traumatic anterior shoulder instability. Clin Sports Med. 2000;19:19-48.

18. Walch G, Boileau P, Levigne C, Mandrino A, Neyret P, Donell S. Arthroscopic stabilization for recurrent anterior shoulder dislocation: results of 59 cases. Arthroscopy 1995;11:173-9.

19. Wolf EM. Arthroscopic capsulolabral repair using suture anchors. Orthop Clin North Am. 1993;24:59-69.

20. Gartsman GM, Roddey TS, Hammerman SM. Arthroscopic treatment of anterior-inferior glenohumeral instability. Two to five-year follow-up. J. Bone Joint Surg Am. 2000;82:991-1003.

21. Koss S, Richmond JC, Woodward JS Jr. Two- to five-year followup of arthroscopic Bankart reconstruction using a suture anchor technique. Am J Sports Med. 1997;25:809-12.

22. O'Neill DB. Arthroscopic Bankart repair of anterior detachments of the glenoid labrum. A prospective study. J Bone Joint Surg Am. 1999;81:1357-66.

23. Tauro JC. Arthroscopic inferior capsular split and advancement for anterior and inferior shoulder instability: technique and results at 2- to 5-year follow-up. Arthroscopy. 2000;16:451-6.

24. McFarland EG, Kim TK, Park HB, Neira CA, Gutierez MI. The effect of variation in definition on the diagnosis of multidirectional instability of the shoulder. J Bone Joint Surg Am. 2003;85:2138-44.

25. Magee DJ. Orthopaedic physical examination. 2nd ed. Philadelphia: WB Saunders; 1992.

26. Jobe FW, Kvitne RS, Giangrarra CE. Shoulder pain in the overhand or throwing athlete. The relationship of anterior instability and rotator cuff impingement. Orthop Rev. 1989;18:963-75. Erratum in: Orthop Rev. 1989;18:1268.

27. Coudane H, Walch G. L'instabilité antérieure chronique de l'épaule chez l'adulte. Symposium de la Sofcot, Paris, 1999. Rev Chir Orthop. 2000;86(Suppl 1):91-150.

28. Gagey OJ, Gagey N. The hyperabduction test. J Bone Joint Surg Br. 2001; 83:69-74.

29. Coste JS, Jund S, Lemaire M, Staccini P, Boileau P, Argenson C. Évaluation arthroscopique du test de laxité du ligament glénohuméral inférieur. Rev Chir Orthop. 1999;85:61.

30. Boileau P, Lafosse L. Évaluation arthroscopique et prospective des lésions d'instabilité antérieure chronique de l'épaule. In: Perspectives en arthroscopie. Berlin: Springer; 2002. p 194-6.

31. Lafosse L, Boileau P, Gartsman G, Flurin P, Hardy P, Imhoff A, Messens S, Kempf J, Toussaint B, Allard M. Correlations arthroscopiques anatomo-cliniques dans l'instabilité chronique antérieure de l'épaule. A propos d'une étude prospective multicentrique de 224 cas. In: Persectives en arthroscopie. Coll. Société Francaise d'Arthroscopie. Berlin: Springer; 2002. p 197-202.

32. Gerber C. Integrated scoring systems for the functional assessment of the shoulder. In: Matsen FA III, Fu FH, Hawkins RJ, editors. The shoulder: a balance of mobility and stability. Rosemont, IL: American Academy of Orthopaedic Surgeons; 1993. p 531-50.

33. Geiger DF, Hurley JA, Tovey JA, Rao JP. Results of arthroscopic versus open Bankart suture repair. Clin Orthop Relat Res. 1997;337:111-7.

34. Guanche CA, Quick DC, Sodergren KM, Buss DD. Arthroscopic versus open reconstruction of the shoulder with isolated Bankart lesions. Am J Sports Med. 1996; 24:144-8.

35. Kartus J, Kartus C, Povacz P, Forstner R, Ejerhed L, Resch H. Unbiased evaluation of the arthroscopic extra-articular technique for Bankart repair: a clinical and radiographic study with a 2- to 5-year follow-up. Knee Surg Sports Traumatol Arthrosc. 2001;9:109-15.

36. Jorgensen U, Svend-Hansen H, Bak K, Pedersen I. Recurrent post-traumatic anterior shoulder dislocation – open versus arthroscopic repair. Knee Surg Sports Traumatol Arthrosc. 1999;7:118-24.

37. Karlsson J, Magnusson L, Ejerhed L, Hultenheim I, Lundin O, Kartus J. Comparison of open and arthroscopic stabilization for recurrent shoulder dislocation in patients with a Bankart lesion. Am J Sports Med. 2001;29:538-42.

38. Sperber A, Hamber P, Karlsson J, Sward L, Wredmark T. Comparison of an arthroscopic and an open procedure for posttraumatic instability of the shoulder: a prospective, randomized multicenter study. J Shoulder Elbow Surg. 2001;10:105-8.

39. Kandziora F, Jager A, Bischof F, Herresthal J, Starker M, Mittlmeier T. Arthroscopic labrum refixation for post-traumatic anterior shoulder instability: suture anchor versus transglenoid fixation technique. Arthroscopy. 2000;16:359-66.

40. Kim SH, Ha Ki, Kim SH. Bankart repair in traumatic anterior shoulder instability: open versus arthroscopic technique. Arthroscopy. 2002;18:755-63.

41. Lafosse L. Anterior arthroscopic shoulder stabilization. What did I learn from my failures. In Boileau, editor. Shoulder arthroplasty and arthroscopy. Current Concepts 2004. Montpellier, France: Sauramps Medical; 2004. p 95-108.

42. Lazarus MD, Sidles JA, Harryman DT 2nd, Matsen FA 3rd. Effect of a chondral-labral defect on glenoid concavity and glenohumeral stability. A cadaveric model. J Bone Joint Surg Am. 1996;78:94-102.

43. Bigliani LU, Newton PM, Steinmann SP, Connor PM, McIlveen SJ. Glenoid rim lesions with recurrent anterior dislocation of the shoulder. Am J Sports Med. 1998;26:41-5.

44. Burkhart SS, De Beer JF. Traumatic glenohumeral bone defects and their relationship to failure of arthroscopic Bankart repairs: significance of the inverted-pear glenoid and the humeral engaging Hill-Sachs lesion. Arthroscopy. 2000;16:677-94.

45. Itoi E, Lee SB, Berglund LJ, Berge LL, An KN. The effect of a glenoid defect on anteroinferior instability of the shoulder after Bankart repair: a cadaveric study. J Bone Joint Surg Am. 2000;82:35-46.

46. Burkhart SS, Danaceau SM. Articular arc length mismatch as a cause of failed bankart repair. Arthroscopy. 2000;16:740-4.

47. Burkhart SS, Debeer JF, Therany AM, Parten PM. Quantifying glenoid bone loss arthroscopically in shoulder instability. Arthroscopy 2002;18:488-91.

48. Lo IK, Parten PM, Burkhart SS. The inverted pear glenoid: an indicator of significant glenoid bone loss. Arthroscopy. 2004;20:169-74.

49. Kim SH, Ha KI, Cho YB, Ryu BD, Oh I. Arthroscopic anterior stabilization of the shoulder: two to six-year follow-up. J. Bone Joint Surg Am. 2003;85:1511-8.

50. Bernageau J, Patte D. Diagnostic radiologique des luxations postérieures de l'épaule. Rev. Chir. Orthop. 1979;65:101-7.

51. Edwards TB, Boulahia A, Walch G. Radiographic analysis of bone defects in chronic anterior shoulder instability. Arthroscopy. 2003;19:732-9.

52. Sugaya H, Moriishi J, Dohi M, Kon Y, Tsuchiya A. Glenoid rim morphology in recurrent anterior glenohumeral instability. J Bone Joint Surg Am. 2003;85:878-84.

53. Griffith JF, Antonio GE, Tong CW, Ming CK. Anterior shoulder dislocation: quantification of glenoid bone loss with CT. AJR Am J Roentgenol. 2003;180:1423-30.

54. Kralinger FS, Golser K, Wischatta R, Wambacher M, Sperner G. Predicting recurrence after primary anterior shoulder dislocation. Am J Sports Med. 2002; 30:116-20.

55. Ito H, Takayama A, Shirai Y. Radiographic evaluation of the Hill-Sachs lesion in patients with recurrent anterior shoulder instability. J Shoulder Elbow Surg. 2000;9:495-7.

56. O'Driscoll SW, Evans DC. Contralateral shoulder instability following anterior repair. An epidemiological investigation. J Bone Joint Surg Br. 1991;73:941-6.

57. McMahon PJ, Dettling J, Sandusky MD, Tibone JE, Lee TQ. The anterior band of the inferior glenohumeral ligament. Assessment of its permanent deformation and the anatomy of its glenoid attachment. J Bone Joint Surg Br. 1999;81:406-13.

58. Walch G, Agostini J, Levigne C, Nove-Josserand L. Instabilité antérieure récidivante avec hyperlaxité multidirectionnelle de l'épaule. Rev Chir Orthop. 1995; 81:682-90.

59. Kempf JF, Lacaze F, Hila A: Instabilité antérieure et hyperlaxité de l'épaule. Instabilité antérieure chronique de l'épaule chez l'adulte. Symposium de la Sofcot, Paris 1999. Rev Chir Orthop. 2000;86(Suppl 1):132-7.

60. Walch G, Boileau P. Latarjet-Bristow procedure for recurrent anterior instability. Tech Shoulder Elbow Surgery. 2000;1:256-61.

61. Boileau P, Ahrens P. The TOTS (temporary outside traction suture): a new technique to allow easy suture placement and improve capsular shift in arthroscopic bankart repair. Arthroscopy. 2003;19:672-7.